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application of those laws which are now correlated under the head of physical chemistry. At the same time we must not be engulfed by this more recent branch of our science, but must always look to her as the handmaiden and not the mistress.

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*THE APPLICATION OF SCIENTIFIC METHOD
TO EDUCATIONAL PROBLEMS*¹

NOTWITHSTANDING the fact that the greater part of my life has been spent in educational work, in teaching, in examining, in organization, and in the investigation of foreign systems of instruction, I have experienced considerable difficulty in selecting, from the large number of subjects that crowd upon me, a suitable one on which to address you as president of a section of the British Association devoted to educational science.

At the outset I am troubled by the title of the section over which I have the honor to preside. I can not refrain from asking myself the question, Is there an educational science, and if so, what is its scope and on what foundations does it rest? The object of the British Association is the advancement of science, and year by year new facts are recorded in different branches of inquiry, on which fresh conclusions can be based. The progress of past years, whether in chemistry, physics or biology, can be stated. Can the same be said, and in the same sense, of education? It is true that the area of educational influence is being constantly extended. Schools of every type and grade are multiplied, but is there any corresponding advance in our knowledge of the principles that should govern and determine our educational efforts, or which can justify us in describing such

knowledge as science? If we take science to mean, as commonly understood, organized knowledge, and if we are to test the claim of any body of facts and principles to be regarded as science by the ability to predict, which the knowledge of those facts and principles confers, can we say that there exists an organized and orderly arrangement of educational truths, or that we can logically, by any causative sequence, connect training and character either in the individual or in the nation? Can we indicate, with any approach to certainty, the effects on either the one or the other of any particular scheme of education which may be provided? It is very doubtful whether we can say that educational science is yet sufficiently advanced to satisfy these tests.

But although education may not yet fulfil all the conditions which justify its claim to be regarded as a science, we are able to affirm that the methods of science, applicable to investigations in other branches of knowledge, are equally applicable to the elucidation of educational problems. To have reached this position is to have made some progress. For we now see that if we are ever to succeed in arriving at fixed principles for guidance in determining the many difficult and intricate questions which arise in connection with the provision of a national system of education, or the solution of educational problems, we must proceed by the same methods of logical inquiry as we should adopt in investigating any other subject matter.

In order to bring education within the range of subjects which should occupy a place in the work of this association, our first efforts should be directed towards obtaining a sufficient body of information from all available sources, past and present, to afford data for the comparisons on which our conclusions may be based. One

¹Address of the president of the Educational Science Section of the British Association for the Advancement of Science, Leicester, 1907.

of the five articles of what is known as the Japanese Imperial Oath states, "Knowledge shall be sought for throughout the whole world, so that the welfare of the empire may be promoted"; and it may certainly be said that, as the welfare of our own empire is largely dependent on educational progress, a wide knowledge of matters connected with education is indispensable, if we are to make advances with any feeling of certainty that we are moving on the right lines.

There can be no doubt that of late years we have acquired a mass of valuable information on all sorts of educational questions. We are greatly indebted for much of our knowledge of what is being done in foreign countries to the reports of different commissions, and more particularly to those special reports issued from the board of education, first under the direction of my predecessor in this chair, Professor Sadler, and latterly of his successor at the board, Dr. Heath. But much of the information we have obtained is still awaiting the hand of the scientific worker to be properly coordinated and arranged. A careful collation of facts is indispensable if we are to deduce from them useful principles for our guidance, and unfortunately we in this country are too apt to rest content when we have provided the machinery for the acquisition of such facts without taking the necessary steps to compare, to coordinate, and to arrange them on some scientific principle for future use. Within the last week or two a bill has passed through several stages in parliament for requiring local authorities to undertake the medical inspection of school children, but, unless the medical inspectors throughout the country conduct their investigations on certain well-considered lines laid down for them by some central authority, we shall fail to obtain the necessary data to enable us to associate educational and physical

conditions with a view to the improvement of the training given in our schools.² On the other hand, although I personally am sceptical as to the results, we have reason to believe that the inquiry recently undertaken into the methods adopted here and elsewhere for securing ethical as distinct from specifically religious training will be so conducted as to give us not only facts, but the means of inferring from those facts certain trustworthy conclusions.

The consideration of education as a subject capable of scientific investigation is complicated by the fact that it necessarily involves a relation—the relation of the child or adult to his surroundings. It can not be adequately considered apart from that relation. We may make a study of the conditions of the physical, intellectual, and ethical development of the child, but the knowledge so obtained is only useful to the educator when considered in connection with his environment and future needs, and the means to be adopted to enable him, as he grows in physical, intellectual and moral strength, to obtain a mastery over the things external to him. Education must be so directed as to prove the proposition that "knowledge is power." It can only be scientifically treated when so considered. Education is imperfectly described when regarded as the means of drawing out and strengthening a child's faculties. It is more than this. Any practical definition takes into consideration the social and economic conditions in which the child is being trained, and the means of developing his faculties with a view to the attainment of certain ends.

² Since this was written the president of the Board of Education has stated in the House of Commons that "it was the intention of the board, if the bill now before parliament passed, to establish a medical bureau, which would guide and advise the local authorities as to the nature of the work they would have to do under the act."

It is in Germany that this fact has received the highest recognition and the widest application, and for this reason we have been accustomed to look to that country for guidance in the organization of our schools. We have looked to Germany because we perceived that some relation had been there established between the teaching given to the people and their industrial and social needs; and further, that their success in commerce, in military and other pursuits was largely due to the training provided in their schools. Unmindful of the fact that education is a relation, and that consequently the same system of education is not equally applicable to different conditions, there were many in this country who were only too ready to recommend the adoption of German methods in our own schools. Experience soon showed, however, that what may have been good for Germany did not apply to England, and that, in educational matters certainly, we do well to follow Emerson, who when addressing his fellow citizens, declared: "We will walk on our own feet; we will work with our own hands, and we will speak our own minds." Still, the example of Germany and the detailed information which we have obtained as to her school organization and methods of instruction have been serviceable to us.

Whilst all information on educational subjects is valuable, I am disposed to think that in our efforts to construct an educational science we may gain more by inquiring what has been effected in some of the newer countries. Wherever educational problems have been carefully considered and schemes have been introduced with the express intention and design of training citizens for the service of the state and of increasing knowledge with a view to such service, those schemes may be studied with advantage. Thus we may learn much from what is now being done

in our colonies. Their efforts are more in the nature of experiments. Our colonies have been wise enough not to imitate too closely our own or any foreign system. They have started afresh, free from prejudice and traditions, and it is for this reason that I look forward with interest to the closer connection in educational matters of the colonies with the mother country, and I believe that we shall gain much knowledge and valuable experience from the discussions of the Federal Conference which has recently been held in London, and which, I understand, is to be repeated a few years hence.

But valuable as are the facts, properly collated and systematically arranged, which a knowledge of British and foreign methods may afford us in dealing scientifically with any educational problem, it is essential that we should be able to test and to supplement the conclusions based on such knowledge, whenever it is possible, by direct experiments, applicable to the matter under investigation. We have not yet recognized the extent to which experiments in education, as in other branches of knowledge, may help in enabling us to build up an educational science. Some years since there was established in Brussels an *Ecole modèle* in which educational experiments were tried. I visited the school in the year 1880, and I could easily point to many improvements in primary education which found their way from that school through the schools of Belgium and France to our own country, and, indeed, to other parts of the world. From a special report on schools in the north of Europe, recently published by the board of education, we learn that in Sweden the value of such experiments is fully recognized. We are told that in that country "it was early felt that the uniformity in state schools was of so strict a kind that some special provision should be made for

carrying out educational experiments," and experiments in many directions have been made, mainly in private schools, which receive, however, special subventions from the state. We gather from the same report that the state regards the money as well earned "if the school occasionally originates new methods from which the schools can derive profit." I venture to think that experimental schools might with advantage be organized under the direction of some of our larger local authorities. The children would certainly not suffer by being made the subjects of such experiments. The intelligent teaching which they would receive—for it is only the most capable teachers who should be trusted with such experiments—would more than compensate for any diminution in the amount of knowledge which the children might acquire, and indeed such experimental schools might be conducted under conditions which would ensure sound instruction. Many improved methods of teaching are constantly advocated, but fail to be adopted because there is no opportunity of giving them a fair trial. As a general rule it is only by the effort of private individuals or associations that changes in system are effected, and teachers are enabled to escape from the old grooves on to new lines of educational thought and practise. It is not difficult to refer to many successful experiments. The general introduction into our schools of manual training was the direct result of experiments carefully arranged and conducted by a joint committee of the city guilds and the late London School Board. Experiments in the methods of teaching physical science, chemistry and geometry have been tried, with results that have led to changes which have revolutionized the teaching of those subjects. The age at which the study of Latin should be commenced with a view to the general educa-

tion of the scholar has been the subject of frequent trial. I would like to see such experiments more systematically organized, and I am quite certain that the curriculum of our rural and of our urban schools would soon undergo very considerable changes, if the suggestions of competent authorities could receive a fair trial under conditions that would leave no manner of doubt as to the character of the results.

It would seem, therefore, that if our knowledge of the facts and principles of education is not yet sufficiently organized to enable us to determine *a priori* the effect on individual or national character of any suggested changes, education is a subject that may be studied and improved by the application to it of scientific method, by accurate observation of what is going on around us, and by experiments thoughtfully conducted. This is the justification of the inclusion of the subject among those that occupy the attention of a separate section of this association. Our aim here should be to apply to educational problems the well known canons of scientific inquiry; and, seeing that the conditions under which alone any investigation can be conducted are in themselves both numerous and complicated, it is essential that we should endeavor to liberate, as far as possible, the discussion of the subject from all political considerations. Such investigations are necessarily difficult. We have to determine both statically and dynamically the physical, mental and moral condition of the child in relation to his activities and surroundings, and we have further to discover how he is influenced by them, how he can affect them, and the character of the training which will best enable him to utilize his experiences, and to add something to the knowledge of to-day for future service.

Notwithstanding the undoubted progress

which we have made, it can not be denied that in this country there still exists a large amount of educational unrest, of dissatisfaction with the results of our efforts during the last thirty years. This is partly due to the fact that there is much loose thinking and uninformed expression of opinion on educational questions. No one knows so little as not to believe that his own opinion is worth as much as another's on matters relating to the education of the people. In this way statements, the value of which has not been tested, pass current as ascertained knowledge, and very often ill-considered legislation follows. In this country, too, the difficulty of breaking away from ancient modes of thought is a great drawback to educational progress. Suggestions for moderate changes, which have been most carefully considered, are deferred and decried if they depart, to any great extent, from established custom, and the objection to change very often rests on no historical foundation. Occasionally, too, the change proposed is itself only a reversion to a previous practise, which was rudely broken by thoughtless and unscientific reformers. The opposition which was so long raised to the establishment of local universities was largely due to want of knowledge on the subject; and certainly the creation, some seventy years ago, of a teaching university in London was actually hindered through a mere prejudice, which broader views as to the real purposes of university teaching and fuller information on the course of university development would have removed.

There never was a time perhaps when it was more necessary than now that education should be regarded dispassionately, apart from political bias, as a matter of vital interest to the people as a whole. Education nowadays is a question which affects not only the life of a few privileged,

selected persons, but of the entire body of citizens. The progress that has been made during the last few years in nationalizing our education has been very rapid. It may be that it has been too rapid, that sufficient thought has not been given to the altered social and industrial conditions which have to be considered. We have witnessed a strong desire and a successful effort to multiply secondary and technical schools and to open more widely the portals of our universities. The object of the desire is good in itself. As the people grow in knowledge the demand for higher education will increase; but the serious question to be considered is whether the kind of education which was supplied in schools, founded centuries ago to meet requirements very different from our own, is equally well adapted to the conditions which have arisen in a state of society having other needs and new ideals. Very rightly our students in training for the profession of teachers are expected to study the writings of Locke, Rousseau, Milton, Montaigne and others; but many are apt to overlook the fact that these writers had in view a different kind of education from that in which modern teachers are engaged, and that their suggestions, excellent as many of them are, were mainly applicable to the instruction to be given by a tutor to his private pupil, and had little or no reference to the teaching of the children of the people in schools expressly organized for the education of the many. Only recently have we come to realize that a democratic system of education, a system intended to provide an intellectual and moral training for all citizens of the state, and so organized that, apart from any consideration of social position or pecuniary means, it affords facilities for the full development of capacity and skill wherever they may occur, must be essentially different in its aims and

methods from that under which many of us now living have been trained. It has also been brought home to us that the marvelous changes in our environment, in the conditions under which we live and work, whether in the field, the factory or the office, have necessitated corresponding changes in the education to be provided as a preparation for the several different pursuits in which the people generally are occupied. Yet, notwithstanding these great forces which have broken in upon and disturbed our former ideals, forces the strength and far-reaching effects of which we readily admit, we still hesitate to face the newly arisen circumstances and to adapt our educational work to its vastly extended area of operation and to the altered conditions and requirements of modern life.

When I say we hesitate to face the existing circumstances I do not wish to be misunderstood. As a fact changes are continually being discussed, and are from time to time introduced into our schools. But such modifications of our existing methods are generally isolated and detached, and have little reference to the more comprehensive measures of reform which are now needed to bring our teaching into closer relation with the changed conditions of existence consequent on the alterations that have taken place in our social life and surroundings.

Four years ago, it will be remembered, a committee of this section was appointed to consider and to report upon the "Courses of Experimental, Observational and Practical Studies most Suitable for Elementary Schools." That committee, of which I had the honor to be chairman, presented a report to this section at the meeting of the association held last year at York. The general conclusion at which they arrived was that "the intellectual and moral training, and indeed to some extent the phys-

ical training, of boys and girls between the ages of seven and fourteen would be greatly improved if active and constructive work on the part of the children were largely substituted for ordinary class teaching, and if much of the present instruction were made to arise incidentally out of, and to be centered around, such work." It is too early, perhaps, to expect that the suggestions made in that report should have borne fruit, but I refer to it because it illustrates the difference between the spasmodic reforms which from time to time are adopted, under pressure from bodies of well-meaning representatives of special interests, and the well-considered changes recommended by a committee of men and women of educational experience who have carefully tested the conclusions at which they have arrived.

There can be no doubt that, as regards our elementary education, there is very general dissatisfaction with its results, since it was first nationalized thirty-seven years ago. Our merchants and manufacturers and employers of labor, our teachers in secondary and technical schools all join in the chorus of complaint. They tell us that the children have gained very little useful knowledge and still less power of applying it. There is enough in this general expression of discontent to give us pause and to make us seek for a rational explanation of our comparative failure. The inadequacy of the results attained to the money and effort that have been expended is in no way due to any want of zeal or ability on the part of the teachers, or of energy on the part of school boards or local authorities. They have all discharged the duties which were imposed upon them. It is due rather to the fact that the problem has been imperfectly understood, that our controlling authorities have had only a vague and indistinct idea of the aim and end of the important

work which they were charged to administer. If we look back upon the history of elementary education in this country since 1870, we can not fail to realize how much its progress has been retarded by errors of administration due very largely to the want of scientific method in its direction. It is painful to reflect, for instance, on the waste of time and effort, and on the false impressions produced as to the real aim and end of education, owing to the system of payment on results, which dominated for so many years a large part of our educational system. We must remember that it is only within the last few decades that education has been brought within reach of all classes of the population. Previously it was for the few; for those who could pay high fees; for those who were training for professional life, whether for the church, the army, the navy, law or medicine, or for the higher duties of citizen life. This had been the case for centuries, not only in this country but in nearly all parts of the civilized world. If we read the history of education in ancient Greece or Rome, or mediæval Europe, we shall see that popular education, as now understood, was unknown. All that was written about education applied to the few who got it, and not to the great mass of the people engaged in pursuits altogether apart from those in which the privileged classes were employed. Trade and manual work were despised, and were considered degrading and unworthy of the dignity of a gentleman. I need scarcely say that these social ideas are no longer held. The fabric of society is changed, and we have to ask ourselves whether the methods of education have been similarly changed, whether they have been wisely and carefully adapted to the new order of things. What is it that has really happened? Is it not true that we have annexed the methods and subjects of

teaching which had been employed during many centuries in the training of the few and applied them to the education of the people as a whole—to those who are engaged in the very callings which were more or less contemned? Surely it is so, and the results are all too manifest. We have applied the principles and methods of the secondary education of the middle ages to our new wants, to the training of the people for other duties than those to which such education was considered applicable, and it is only within the last few years that we have begun to see the error of our ways. In the report of your committee, to which I have referred, it is pointed out that the problem of primary education has been complicated by the introduction of the methods which for many years prevailed in secondary schools, and at a meeting of the National Education Association, held only a few weeks since, it was truly said: "In this country secondary education preceded primary by several centuries, and so the nation now finds itself with the aristocratic cart attempting to draw the democratic horse."

Let it not be supposed that in the days not so far distant, yet stretching back into the remote past, the people as a whole were uneducated. This was not so. But we have to widen the meaning of education to include the special training which the people then received—an education that was acquired without even the use of books. It can not for one moment be said that the artisans, the mechanics, the farm hands, male and female, were wholly uneducated in those far-off days. In one sense possibly they were. Very few of them could read or write. But from earliest childhood they had received a kind of training the want of which their descendants have sadly felt in the cloistered seclusion of the modern elementary school. They were brought face to face with

nature. They learned the practical lessons of experience; and as they grew up their trade apprenticeship was an education which we have been trying vainly to reproduce. They gained some knowledge of the arts and sciences, as then understood, underlying their work. Their contact with their surroundings made them thoughtful and resourceful, for nature is the most exacting and merciless of teachers. The difficulties they had to overcome compelled them to think, and of all occupations none is more difficult. They were constantly putting forth energy, adapting means to ends, and engaging in practical research. In the field, in the workshop, and in their own homes boys and girls acquired knowledge by personal experience. Their outlook was broad. They learned by doing. It is true that nearly all their occupations were manual, but Emerson has told us, "Manual training is the study of the external world."

Compare for a moment this training with that provided in a public elementary school, and you can not be surprised to find that our artificial teaching has failed in its results, that our young people have gained very little practical knowledge, and that what they have gained they are unable to apply; that they lack initiative and too often the ability to use books for their own guidance, or the desire to read for self-improvement. We seem to have erred in neglecting to utilize practical pursuits as the basis of education, and in failing to build upon them and to evolve from them the mental discipline and knowledge that would have proved valuable to the child in any subsequent occupation or as a basis for future attainments. We have made the mistake of arresting, by means of an artificial literary training, the spontaneous development of activity, which begins in earliest infancy and continues to strengthen as the child is brought into ever closer con-

tact with his natural surroundings. We have provided an education for our boys which might have been suitable for clerks; and, what is worse, we have gone some way, although we have happily cried a halt, to make our girls into "ladies," and we have run some risk of failing to produce women.

If we are to correct the errors into which we have drifted, if we are to avert the consequences that must overtake us through having equipped our children for their life-struggle with implements unfitted for their use, we must consider afresh the fundamental ideas on which a system of elementary education should be based. Instead of excluding the child from contact with the outer world we must bring him into close relationship with his surroundings. It was given to man to have dominion over all other created things, but he must first know them. It is in early years that such knowledge is most rapidly acquired, and it is in gaining it that the child's intellectual activities are most surely quickened.

It is unfortunate that we failed to realize this great function of elementary education when we first essayed to construct for ourselves a national system. The three R's, and much more than that, are essential and incidental parts of elementary education. But what is needed is a *Leitmotif*—a fundamental idea underlying all our efforts and dominating all our practise, and I venture to think that that idea is found in basing our primary education on practical pursuits, on the knowledge gained from actual things, whether in the field, the workshop or the home.

Instead of fetching our ideas as to the training to be given in the people's schools from that provided in our old grammar schools, we should look to the occupations in which the great mass of the population

of all countries are necessarily engaged, and endeavor to construct thereon a system with all such additions and improvements as may be needed to adapt it to the varied requirements of modern life. By this process—one of simple evolution adjusted to everyday needs—a national system of education might be built up fitted for the nation as a whole—a system founded on ideas very different from those which, through many centuries, have governed the teaching in our schools. In the practical pursuits connected with the field, the workshop and the home, and in the elementary teaching of science and letters incidental thereto, we might lay the foundation of a rational system of primary education.

These three objects—the field, the workshop and the home—should be the pivots on which the scheme of instruction should be fixed, the central thoughts determining the character of the teaching to be given in rural and urban schools for boys and girls. It was Herbart who insisted on the importance of creating a sort of center around which school studies should be grouped with a view to giving unity and interest to the subjects of instruction. I have elsewhere shown how a complete system of primary education may be evolved from the practical lessons to be learned in connection with out-door pursuits, with workshop exercises and with the domestic arts, and how, by means of such lessons, the child's interest may be excited and maintained in the ordinary subjects of school instruction, in English, arithmetic, elementary science and drawing. In the proposals I am now advocating I am not suggesting any narrow or restricted curriculum. On the contrary, I believe that, by widening the child's outlook, by closely associating school work with familiar objects, you will accelerate his mental development and quicken his power of acquiring knowledge. I would strongly

urge, however, that the child should receive less formal teaching, that opportunities for self-instruction, through out-door pursuits, or manual exercises, or the free use of books, should be increased, so that as far as possible the teacher should keep in view the process by which in infancy and in early life the child's intelligence is so rapidly and marvelously stimulated. Already we have discovered that our unscientific attitude towards primary education has caused us to overlook the essential difference between the requirements of country and of town life, and the training proper to boys and girls. Our mechanical methods of instruction, as laid down in codes, make for uniformity rather than diversity, and we are only now endeavoring, by piecemeal changes, to bring our teaching somewhat more closely into relation with existing needs. But the inherent defect of our system is that we have started at the wrong end, and, instead of evolving our teaching from the things with which the child is already familiar, and in which he is likely to find his life's work, we have taken him away from those surroundings and placed him in strange and artificial conditions, in which his education seems to have no necessary connection with the realities of life.

The problem of primary education is to teach by practical methods the elements of letters and of science, the art of accurate expression, the ability to think and to control the will; and the ordinary school lessons should be such as lead to the clear apprehension of the processes that bring the child into intimate relation with the world in which he moves. During the last few years the importance of such teaching has dimly dawned upon our educational authorities, but, instead of being regarded as essential, it has been treated as a sort of *extra* to be added to a literary curriculum, already overcrowded. What is

known as manual training is to some extent encouraged in our schools, but it forms no part of the child's continuous education. It is still hampered with conditions inconsistent with its proper place in the curriculum, and is uncoordinated with other subjects of instruction. Moreover no connecting link has yet been forged between the teaching of the kindergarten and workshop practise in the school. We speak of lessons in manual training as something apart from the school instruction, as something outside the school course, on the teaching of which special grants are paid. Twenty or thirty years ago people used to talk about "teaching technical education," and from this unscientific way of treating the close connection that should exist between hand-work and brain-work our authorities have not yet freed themselves.

It is true we have long since passed that stage when it was thought that the object of instruction in the use of tools was to make carpenters or joiners; but, judging from a report recently issued by the board of education, it would seem that it is still thought that the object of cookery lessons to children of twelve to fourteen years of age is the training of professional cooks. Until the board's inspectors can be brought to realize that the aim and purpose of practical instruction in primary schools, whether in cookery or in other subjects, is to train the intelligence through familiar occupations, to show how scientific method may be usefully applied in ordinary pursuits, and how valuable manipulative skill may thus be incidentally acquired, it does not seem to me that they themselves have learned the most elementary principles of their own profession. An anonymous teacher, writing some weeks since in the *Morning Post*, said:

The cookery class can be made an invaluable mental and moral training ground for the pupils, the most stimulating part of primary education.

It teaches unforgettable lessons of cleanliness and order, of quickness and deftness of movements. The use of the weights and scales demands accuracy and carefulness, and the raw materials punish slovenliness or want of attention with a thoroughness which the most severe of schoolmasters might hesitate to use. Practical lessons in chemistry should form an important feature of each class. . . . The action of heat and moisture on grains of rice provides an interesting lesson on the bursting of starch cells, and the children's imagination is awakened by watching the hard isolated atoms floating in milk change slowly to the creamy softness of a properly made rice pudding. The miraculous change in the oily white of egg when it is beaten into a mountain of snowy whiteness gives them interest in the action of air and its use in cookery.

Can the teaching of grammar or the analysis of sentences provide lessons of equal value in quickening the intelligence of young children?

I must add one word before passing from this suggestive illustration of the value of scientific method in the treatment of educational questions. We live in a democratic age, and any proposed reform in the teaching of our primary schools must be tested by the requirement that the revised curriculum shall be such as will provide not only the most suitable preparatory training for the occupations in which four fifths of the children will be subsequently engaged, but will, at the same time, enable them or some of them to pass without any breach of continuity from the primary to the secondary school. There must be no class distinctions separating the public elementary from the state-aided secondary school. The reform I have suggested is unaffected by such criticism. The practical training I have advocated, whether founded on object lessons furnished by the field, the workshop or the home, would prove the most suitable for developing the child's intelligence and aptitudes and for enabling him to derive the utmost advantage from attendance at any one of the different types of

secondary schools best fitted for his ascertained abilities and knowledge. The bent of the child's intellect would be fully determined before the age when the earliest specialization would be desirable. No scheme of instruction for primary schools can be regarded as satisfactory, which is not so arranged that, whilst providing the most suitable teaching for children who perforce must enter some wage-earning pursuit at the age of fourteen, or at the close of their elementary school course, shall at the same time afford a sound and satisfactory basis on which secondary and higher education may be built. And I hold the opinion, in which I am sure all teachers will concur, that a scheme of primary education pervaded by the spirit of the kindergarten which, by practical exercises, encourages observation and develops the reasoning faculties, and creates in the pupil an understanding of the use of books, would form a fitting foundation for either a literary or a scientific training in a secondary school.

I have purposely chosen to illustrate the main subject of this address by reference to defects in our primary instruction, because the success of our entire system of education will be found, year by year, to depend more and more upon the results of the training given in our public elementary schools. We have scarcely yet begun to realize the social and political effects of the momentous changes in our national life, consequent on the first steps which were taken less than forty years ago to provide full facilities under state control and local management for the education of the people.

At present all sorts of ideas are afloat which have to be carefully and scientifically considered. The working classes have to be further and somewhat differently educated, in order that they may better understand their own wants and how they are

to be satisfied. We have placed vast powers in the hands of local bodies, popularly elected, powers not only of administration, for which they are well adapted, but powers of determining to a very great extent, by the free use of the rates, the kind of instruction to be given in our schools, and the qualifications of the teachers to impart it. Moreover, these local bodies have shown, in many instances, a distrust of expert advice and a desire to act independently as elected representatives of the people, which can not fail for some time at least to lead to waste of effort and of means. It was said years ago, when the center of our political forces received a marked displacement, that we must educate our masters. Our masters now, both in politics and education, are the people, and it is only, I believe, by improving their education that we can enable them to understand the essential difficulties of the problems which they are expected to solve, and can induce them to rely, to a greater extent than they do at present, on the results of the application to such problems of scientific method, founded on the fullest information obtainable from historical and contemporary sources.

I might have illustrated my subject by reference to the acknowledged chaotic condition of our secondary education. In the report of the board of education published in December last we read:

While the development of secondary education is the most important question of the present day, and is the pivot of the whole education as it affects the efficiency, intelligence and well-being of the nation, yet its present position may be described as "chaos."

The "chaos" by which the present position of our secondary education is here described is intimately connected with the questions relating to primary education, which I have been engaged in considering. If we construct a system of primary education which serves equally for children of

all classes, apart from social conditions—a system educationally sound, both as a preparation for immediate wage-earning pursuits and for more advanced and somewhat more specialized training in a secondary school, many of the difficulties which confront the board of education, and which are largely of an administrative order, would disappear. The difficulties are in part dependent on the question of curriculum, to the discussion of which a day will be devoted during the present meeting.

University education in this country, and indeed in other countries, has also suffered much from the hands of the unscientific reformer. In Germany, owing to many causes, the higher education has made considerable advances during the past century; but, even in that country, a more critical study of the development of university education and a truer recognition of the twofold function of a university might have prevented the early separation in distinct institutions and under separate regulations of the higher technical from university instruction. Only within recent years has France retraced her steps and returned to the university ideal of seven centuries ago. But perhaps the climax of unscientific thinking was reached in the scheme, happily abandoned, of founding a new university in Dublin on the lines suggested by Mr. Bryce in his now famous speech of January last.

Our conception of the functions of a university has undergone many violent changes. Between the ideal of the University of London prior to its reorganization and that of a medieval university, in which students were never plucked, obtaining their degrees whether they did their work well or badly, there have been many variations; but I think it may be said that, recently at any rate, we have come to realize the fact that our universi-

ties, to fulfil their great purpose, must be schools for the preparation of students for the discharge of the higher duties of citizenship and professional life, and institutions for the prosecution of research, with a view to the promotion of learning in all its branches, and that examinations for degrees, necessary, as they undoubtedly are, as tests of the extent of a student's acquired knowledge, must be regarded as subordinate to these two great functions.

I will not detain you longer. I have endeavored to show under what limitations education may lay claim to be included among the sciences, and how a knowledge of the history of education and the application of the methods of scientific inquiry may help in enabling us to solve many of the intricate and complicated questions which are involved in the establishment on a firm foundation of a national system of education. I have taken my illustrations mainly from the reform of elementary, or, as I prefer to call it, primary education, and I have sought to indicate some of the errors into which we may fall when we fail to apply to the consideration of the problem the same principles of inductive inquiry as are employed in all investigations for the attainment of truth.

I believe that this section of the British Association has the opportunity of rendering a great service to the state. Numerous educational societies exist, in which questions of importance are discussed, and all, perhaps, do useful work. But none is so detached from separate and special interests; none stands so essentially apart from all political considerations; none is so competent to discuss educational problems from the purely scientific standpoint as are the members of this association. If, in the remarks I have offered, somewhat hastily prepared under the pressure of many different kinds of work, I have contributed anything to the solution of a problem, the

difficulty and national importance of which all will admit, I shall feel that I have not been altogether unworthy of the honor of occupying this chair.

PHILIP MAGNUS

SCIENTIFIC BOOKS

Report on the Diatoms of the Albatross Voyages in the Pacific Ocean, 1888-1904. By ALBERT MANN. Assisted in the bibliography and citations by P. L. RICKER. Contributions from the United States National Herbarium, Vol. X., Part 5. Washington, Government Printing Office. 1907.

According to the author, the object of this report is, first, to contribute to the systematic study of the diatoms, and, second, to call attention to the value of further investigations in this field for throwing light upon certain meteorological and geological problems connected with marine investigations. There also has been prepared a set of carefully identified specimens of all the species enumerated, including types of all new species, which collection has been deposited in the United States National Museum. On account of the inadequate methods used in making the gatherings from the *Albatross*, the number of species listed is not nearly so great as might be expected. In fact, considering the large number of soundings and dredgings made and the years over which the work extends, the results are disappointing. It seems unfortunate that the amount of energy and time necessary to properly examine gatherings of this kind should have to be wasted upon barren samples, when the adoption of other methods would have undoubtedly resulted in rich hauls of diatoms. Critical notes upon some three hundred species, thirty-seven of which are new, are given and a sufficiently full discussion of the fifty odd genera concerned is included. The account of the species discussed is considerably more than a mere list, and is of such worth that one regrets all the more the limitations which have been put upon the work. A most careful comparison of the views of various authorities upon each species has been made and should do much towards giving a

really clear conception of the forms discussed. When one considers the inaccessibility of a large amount of the literature upon the diatoms, it seems probable that this part of the report will be one of the most helpful features.

While it may not have been practicable under the circumstances to prepare an absolutely exhaustive list of the synonymy, there seems to be no reason for the omission of names elsewhere cited, even though "the horde of synonyms would be so great as to become most misleading unless accompanied by extensive explanations." Instead of such a discussion "being quite foreign to the purpose of this report" it would seem to be the very place in which to set forth as fully as might be necessary, the reasons for retaining or rejecting names. Certainly the present chaotic conditions of the nomenclature of the diatoms can not be cleared up so long as this tedious but necessary aspect of the subject is disregarded.

The number of stations from which diatoms were collected was altogether too meager to warrant any generalizations regarding either the origin of the bottom from which they came, or the course of the ocean currents which carried them. However, the importance of planning future work with such an end in view is very properly pointed out and some good examples are given of specific knowledge of this character being obtained from a study of the diatoms of a given region.

It is a satisfaction to know that all of the species reported upon have been permanently mounted in such a way as to make them readily accessible to those who may have occasion to refer to them. Not only is there a series of group slides containing specimens of all the forms gathered in a specific locality, but each species has been mounted separately, and the position definitely indicated so that it may be instantly found under the microscope. The value of such a set of slides can only be appreciated by those who have had to search for a particular species in the heterogeneous mass of diatoms and other organisms with which it is usually mounted.